CLAIMS

WHAT IS CLAIMED IS:

1. A method of testing cement comprising:

introducing cement into a curing vessel that is at least partially inside a test vessel;

curing the cement at a selected temperature and pressure;

maintaining the cement at least at the selected temperature and pressure after the cement has cured and until testing of the cement; and

testing the cement for a performance property.

2. The method of claim 1 further comprising the curing vessel being filled with a curing vessel fluid and the test vessel being filled with a test vessel fluid before introducing the cement into the curing vessel such that there is substantially no pressure differential between the inside and the outside of the curing vessel.

3. The method of claim 1 further comprising displacing a curing vessel fluid from the curing vessel when introducing the cement into the curing vessel, test vessel being at the selected temperature and pressure and there being substantially no pressure differential between the inside and outside of the curing vessel.

4. The method of claim 3 further comprising:

comparing the cement going into the curing chamber with the material being displaced out of the curing vessel to verify that no curing vessel fluid remains in the curing chamber; and

placing a selected curing vessel fluid head on the cement.

5. The method of claim 3 further comprising maintaining substantially no pressure differential between the inside and the outside of the curing vessel as the cement is introduced into the curing vessel.

6. The method of claim 1 further comprising introducing the cement through a first fluid line controlled by a first valve, the curing vessel comprising first and second end caps and a flexible sleeve adapted to contain the cement within the curing vessel.

7. The method of claim 1 further comprising increasing the temperature and pressure of the test vessel to a selected temperature and pressure while maintaining substantially no pressure differential between the inside and the outside of the curing vessel until the test vessel reaches the selected temperature and pressure.

8. The method of claim 1 further comprising allowing the pressure differential between the inside and the outside of the curing vessel to adjust as the cement cures.

9. The method of claim 1 further comprising maintaining the pressure in the test vessel above 5000 pounds per square inch while the cement cures.

10. The method of claim 1 further comprising maintaining the pressure in the test vessel with a pressure regulator.

11. The method of claim 1 further comprising maintaining the temperature in the test vessel above 250 °F while the cement cures.

12. The method of claim 1 further comprising maintaining the temperature in the test vessel with a heating jacket around the test vessel.

13. The method of claim 6 further comprising measuring the change in volume of the cement in the curing vessel during curing.

14. The method of claim 13 further comprising measuring the change of the cement in the radial dimension with a first strain gauge and measuring the change of the cement in the axial dimension with a second strain gauge.

15. The method of claim 14 further comprising the first strain gauge measuring the change of the curing vessel sleeve in the radial dimension and the second strain gauge measuring the change of at least one of the first and second end caps in the axial dimension.

16. The method of claim 1 where the testing of the cement comprises a test selected from the group consisting of hydrostatic, unconfined, confine, uni-axial, hydrostatic cycling, confine axial, shear bonding, and pore pressure cycling.

17. The method of claim 1 where the testing of the cement comprises a test measuring a parameter selected from the group consisting of axial pressure, radial pressure, pore pressure, axial strain, circumferential strain, longitudinal acoustic velocity, shear acoustic velocity, water of hydration, heat of hydration, and permeability.

18. The method of claim 1 where the performance property is selected from the group consisting of Young's Modulus, Poisson's Ratio, Fatigue, Failure Strength, Dynamic Young's Modulus, and Dynamic Poisson's Ratio.

19. The method of claim 1 further comprising testing the cement by adjusting the pressure inside the curing vessel with a pressure fluid inlet line.

20. The method of claim 1 further comprising testing the cement by adjusting the volume of the curing vessel.

21. The method of claim 20 further comprising adjusting the volume of the curing vessel by moving at least one of a first and second curing vessel end cap.

22. The method of claim 1, the curing vessel comprising first and second end caps and a flexible sleeve adapted to contain the cement within the curing vessel.

23. The method of claim 22 where the flexible sleeve is rubber.

24. The method of claim 23 where the flexible sleeve is Viton.

25. A method of testing cement comprising:

displacing a curing vessel fluid from within a curing vessel by introducing cement into the curing vessel, the curing vessel being at least partially inside a test vessel at a selected temperature and pressure;

maintaining substantially no pressure differential between the inside and the outside of the curing vessel as the cement is introduced into the curing vessel;

curing the cement at the selected temperature and pressure;

maintaining the cement at least at the selected temperature and pressure after the cement has cured and until testing of the cement; and

testing the cement for a performance property.

26. The method of claim 25 further comprising the test vessel being filled with a test vessel fluid.

27. The method of claim 25 further comprising the test vessel being at the selected temperature and pressure and there being substantially no pressure differential between the inside and outside of the curing vessel.

28. The method of claim 25 further comprising:

comparing the cement going into the curing vessel with the material being displaced out of the curing vessel to verify that no curing vessel fluid remains in the curing vessel; and

placing a selected curing vessel fluid head on the cement.

29. The method of claim 25 further comprising introducing the cement through a first fluid line controlled by a first valve, the curing vessel comprising first and second end caps and a flexible sleeve adapted to contain the cement within the curing vessel.

30. The method of claim 25 further comprising allowing the pressure differential between the inside and the outside of the curing vessel to adjust as the cement cures.

31. The method of claim 25 further comprising maintaining the pressure in the test vessel above 5000 pounds per square inch while the cement cures.

32. The method of claim 25 further comprising maintaining the pressure in the test vessel with a pressure regulator.

33. The method of claim 25 further comprising maintaining the temperature in the test vessel above 250 °F while the cement cures.

34. The method of claim 25 further comprising maintaining the temperature in the test vessel with a heating jacket around the test vessel.

35. The method of claim 29 further comprising measuring the change in volume of the cement in the curing vessel during curing.

36. The method of claim 35 further comprising measuring the change of the cement in the radial dimension with a first strain gauge and measuring the change of the cement in the axial dimension with a second strain gauge.

37. The method of claim 36 further comprising the first strain gauge measuring the change of the curing vessel sleeve in the radial dimension and the second strain gauge measuring the change of at least one of the first and second end caps in the axial dimension.

38. The method of claim 25 where the testing of the cement comprises a test selected from the group consisting of hydrostatic, unconfined, confine, uni-axial, hydrostatic cycling, confine axial, shear bonding, and pore pressure cycling.

39. The method of claim 25 where the testing of the cement comprises a test measuring a parameter selected from the group consisting of axial pressure, radial pressure, pore pressure, axial strain, circumferential strain, longitudinal acoustic velocity, shear acoustic velocity, water of hydration, heat of hydration, and permeability.

40. The method of claim 25 where the performance property is selected from the group consisting of Young's Modulus, Poisson's Ratio, Fatigue, Failure Strength, Dynamic Young's Modulus, and

Dynamic Poisson's Ratio.

41. The method of claim 25 further comprising testing the cement by adjusting the volume of the curing chamber.

42. The method of claim 41 further comprising adjusting the volume of the curing chamber by moving at least one of a first and second curing vessel end caps.

43. The method of claim 25, the curing vessel comprising first and second end caps and a flexible sleeve adapted to contain the cement within the curing vessel.

44. The method of claim 43 where the flexible sleeve is rubber.

45. The method of claim 44 where the flexible sleeve is Viton.

46. A method of testing cement comprising:

introducing cement into a curing vessel at least partially inside a test vessel;

placing a selected curing vessel fluid head on the cement;

increasing the temperature and pressure of the test vessel to a selected temperature and pressure while continuing to maintain substantially no pressure differential between the inside and the outside of the curing vessel until the test vessel reaches the selected temperature and pressure;

curing the cement at a selected temperature and pressure;

maintaining the cement at least at the selected temperature and pressure after the cement has cured and until testing of the cement; and

testing the cement for a performance property.

47. The method of claim 46 further comprising introducing the cement through a first fluid line controlled by a first valve, the curing vessel comprising first and second end caps and a flexible sleeve adapted to contain the cement within the curing vessel.

48. The method of claim 46 further comprising increasing the temperature and pressure of the test

vessel to a selected temperature and pressure while maintaining substantially no pressure differential between the inside and the outside of the curing vessel until the test vessel reaches the selected temperature and pressure.

49. The method of claim 46 further comprising allowing the pressure differential between the inside and the outside of the curing vessel to adjust as the cement cures.

50. The method of claim 46 further comprising maintaining the pressure in the test vessel above 5000 pounds per square inch while the cement cures.

51. The method of claim 46 further comprising maintaining the pressure in the test vessel with a pressure regulator.

52. The method of claim 46 further comprising maintaining the temperature in the test vessel above 250 °F while the cement cures.

53. The method of claim 46 further comprising maintaining the temperature in the test vessel with a heating jacket around the test vessel.

54. The method of claim 47 further comprising measuring the change in volume of the cement in the curing vessel during curing.

55. The method of claim 54 further comprising measuring the change of the cement in the radial dimension with a first strain gauge and measuring the change of the cement in the axial dimension with a second strain gauge.

56. The method of claim 55 further comprising the first strain gauge measuring the change of the curing vessel sleeve in the radial dimension and the second strain gauge measuring the change of at least one of the first and second end caps in the axial dimension.

57. The method of claim 46 where the testing of the cement comprises a test selected from the

group consisting of hydrostatic, unconfined, confine, uni-axial, hydrostatic cycling, confine axial, shear bonding, and pore pressure cycling.

58. The method of claim 46 where the testing of the cement comprises a test measuring a parameter selected from the group consisting of axial pressure, radial pressure, pore pressure, axial strain, circumferential strain, longitudinal acoustic velocity, shear acoustic velocity, water of hydration, heat of hydration, and permeability.

59. The method of claim 46 where the performance property is selected from the group consisting of Young's Modulus, Poisson's Ratio, Fatigue, Failure Strength, Dynamic Young's Modulus, and Dynamic Poisson's Ratio.

60. The method of claim 46 further comprising testing the cement by adjusting the volume of the curing chamber.

61. The method of claim 60 further comprising adjusting the volume of the curing chamber by moving at least one of a first and second curing vessel end caps.

62. The method of claim 46, the curing vessel comprising first and second end caps and a flexible sleeve adapted to contain the cement within the curing vessel.

63. The method of claim 62 where the flexible sleeve is rubber.

64. The method of claim 63 where the flexible sleeve is Viton.

65. A testing apparatus for testing cement comprising:

a test vessel comprising a fluid-filled test chamber;

a curing vessel at least partially within the test chamber comprising a first end cap, a second end cap, and a flexible sleeve, the curing vessel being sealed from the fluid in the test chamber; and

the first and second end caps adapted to selectively adjust the volume of the curing vessel.

66. The testing apparatus of claim 65 further comprising a radial deformation gauge comprising a radial deformation measurement band around the flexible sleeve and a spring-loaded strain gauge adapted to measure change of the radial deformation band in the radial dimension corresponding to the change in the radial dimension of the flexible sleeve.

67. The testing apparatus of claim 65 where the flexible sleeve is rubber.

68. The testing apparatus of claim 67 where the flexible sleeve is Viton.

69. The testing apparatus of claim 67 further comprising a first temperature measurement device adapted to measure the temperature of the cement and a second temperature measurement device adapted to measure the temperature of the test chamber.

70. The testing apparatus of claim 65 further comprising a curing vessel inlet line and a curing vessel outlet line adapted to adjust the pressure within the curing vessel.

71. The testing apparatus of claim 65 further comprising a test vessel inlet line adapted to adjust the pressure within the test chamber.

72. The testing apparatus of claim 65 further comprising a first pressure measurement device adapted to measure the pressure inside the curing vessel and a second pressure measurement device adapted to measure the pressure inside the test vessel.

73. The testing apparatus of claim 65 further comprising a heating jacket for adjusting the temperature within the test chamber.

74. The testing apparatus of claim 70 wherein the curing vessel inlet line is in fluid communication with the first end cap and the curing vessel outlet line is in fluid communication with the second end cap.

75. The testing apparatus of claim 74 further comprising a first valve to control flow through the

curing vessel inlet line and a second valve to control flow through the curing vessel outlet line.

76. The testing apparatus of claim 65 further comprising an axial deformation gauge comprising a axial strain gauge adapted to measure the axial movement of at least one of the first and second end caps.